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RESEARCH ARTICLE

Reinforced concrete in Louis Kahn's National Assembly, Dhaka: Modernity and modernism in Bangladeshi architecture

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Abstract
Louis Kahn is often credited with having in his National Assembly in Dhaka (1962–1983) introduced modern architecture to Bangladesh. In fact at least as technologically advanced construction as any he employed was already in use there. Nor was he the first to use a sophisticated abstract esthetic in what was from 1947 to 1971 East Pakistan. The importance and originality of the National Assembly instead resides in the care with which he built in reinforced concrete and the forms into which he required that it be cast. These were esthetic decisions rooted in a particular theoretical position; they were located outside established modernist practice of the time in both South Asia and the United States. Indeed operating at such a great remove from home may have heightened Kahn's authority to implement these forms even as it substantially complicated their execution.

1. Introduction

The National Assembly in Dhaka is Bangladesh's most famous modern building (Figure 1). Designed by Louis Kahn, who received the commission in 1962, when the Bangladesh was East Pakistan, it was completed only in 1983, nine years after its architect's death. Since receiving an Aga Khan Award in 1989, it has become one of the world's most celebrated structures. The attention paid to it, and in particular to the way in which Kahn used concrete for its monolithic walls has overridden an awareness of the inroads that both modern

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Figure 1 National Assembly, Kahn, Dhaka, Bangladesh, 1983. *Source*: Wikimedia Commons.

construction techniques and modernist forms had already made in the city, and also of the way in which Kahn's use of concrete often differed from the international mainstream of the period.

Modern architecture claimed to represent modernity, above all through the use of abstract forms generated out of the properties of the new materials, such as steel and concrete, used to construct them. Yet reinforced concrete was often used, especially in European colonies, far in advance of the arrival of the industrialization they were supposed to represent. Moreover, there was substantial disagreement about what the chief properties of these materials actually were and thus about what forms were most appropriate to them. Was reinforced concrete's chief virtue its plasticity, its monumentality, or its ability to frame undivided spaces? And should architects, engineers, or builders decide? Kahn's attempt to override the way in which reinforced concrete was typically used in East Pakistan in the early 1960s shows him attempting to use his authority as an imported western expert in order to introduce practices that adhered to his personal theoretical and esthetic position rather than to local or international norms.

2. Concrete, engineering, and architecture in colonial India

Historians of concrete have focused on the development of the material in France, Germany, and the United States (Collins, 2004; Forty, 2012; Saint, 2008; Simonnet, 2005). Little effort has been made to map the spread of its use around the world, but it is clear that it was very rapid (Forty, 2012). It was certainly widely used almost immediately, for instance, in France's North African colonies, not least because little skilled labor was required; one could simply buy a design from major contractors like Hennebique (Simonnet, 2005). Architects played at best a marginal role in this process.

Reinforced concrete was in use in colonial India by 1901 and was widely available in major cities, particularly Bombay (now Mumbai) during the second quarter of the century. Most concrete construction in colonial India was nominally supervised by British engineers but actually executed by Indian engineers. Both cement and reinforcing iron were soon manufactured locally. The low cost of labor meant, however, that mechanization remained rudimentary, with most concrete being mixed by hand and much of it carried into position on the heads of poorly paid women. Because British standards were followed without taking proper account of the tropical climate, some of this work was not of very high quality (Tappin, 2003).

The rapid spread of concrete to colonial India was far from a unique case of South Asian modernity. Vast tracts of what are now Bangladesh, India, and Pakistan remained rural and resolutely preindustrial, but key developments in astrophysics and quantum mechanics were occurring in Calcutta and Dhaka, the two largest cities in the as yet undivided province of Bengal. The work of Meghnad Saha and Satyendra Nath Bose, both graduates of Presidency College in Calcutta, represented the apex of the educational system that also produced many talented engineers; India's first engineering college was established in Roorkee in 1847. The quality of the training in structural engineering continued to be outstanding after independence. Fazlur Khan, for instance, earned his undergraduate degree in civil engineering from Ansullah Engineering College at the University of Dhaka, before immigrating to the United States, where he developed the tubular structural system for tall buildings (Ali, 2001; Khan, 2004). Professional education in architecture, however, lagged well behind. Although there were experienced professional practices led by British expatriates in the major cities, and a few architectural schools had opened before independence, there were far fewer architects than engineers (MARG, 1948). This had profound repercussions on postcolonial architecture on the subcontinent, as prestigious commissions were routinely outsourced to foreigners.

The shortage of architects did not prevent metropolitan Indian architecture from being up to date in style as well as construction. In the last years before World War II, a streamlined Art Deco most often associated with cinema architecture, but also used for office buildings and apartment blocks, was commonly employed across major cities. Architects designed many of the most sophisticated examples, like the apartment buildings and hotels lining Bombay's Marine Drive (Evenson, 1989). It was also widely employed in the low rise, middle class housing being constructed long before independence in the railways suburbs of the subcontinent's major cities (Rao, 2013). In both cases, a version of Le Corbusier's Domino scheme predominated. A concrete frame was filled in with masonry walls, and the distinction between the two obscured with a layer of stucco, often sporting subdued decorative details. Concrete in mid-twentieth-century South Asian architecture was thus mostly a convenience, offering solidity at relatively modest cost.

3. Concrete in post-independence south Asia

Following the independence of India and Pakistan in 1947, the subcontinent became a showcase for the most modern architecture of the 1950s and sixties, much of it built by imported experts out of reinforced concrete. Across the subcontinent the leaders of newly independent countries used up to date architecture, much of it designed by

imported experts, to signal the modernity of their new states. New cities abounded, including in India alone the new capitals of Bhubaneswar, Chandigarh, and Gandhinagar. The new Pakistani capital of Islamabad was designed with the assistance of a raft of European and American architects, including Constantinos Doxiadis and Edward Durrell Stone (Doxiadis, 1965; James-Chakraborty, 2008).

Entirely independently of Kahn, three different approaches to concrete co-existed in this context. The first was skeletal framing, in which stucco could be expected to eventually cover both the concrete and the brick infill. The second was monolithic concrete, typically with very rough finishes. And the third was lightweight shell construction. All were pioneered in Europe but only the first was widely used in Dhaka already in 1962; Kahn would struggle with to revise the second and use the third only when absolutely necessary.

A 1964 report supplied to Kahn by an employee of the Pakistani Public Works Department spelled out the way in which concrete was typically used there:

> In East Pakistan concrete is on one of the expensive items in the building industry as the cost of cement, sand, and shingle is exorbitant. Under these circumstances practically all the high buildings in Dacca are made of RCC frame, having brick panel walls to get uniformity and smooth surface after plastering the walls with a rich mortar in cement and sand. The outside walls and columns can be ornamentally treated with different types of finishing materials and ornamental brick facing. Under these circumstances it is suggested that the idea of making reinforced concrete without any sort of rendering (plaster) should be abandoned altogether.[1]

This way of using concrete had a long history within as well as outside the modern movement in architecture, which had developed in part to exploit the kinds of spaces it made possible. Le Corbusier's Masion Domino scheme of 1914 was an early and particularly lucid European articulation of this system (Curtis, 1986) (Figure 2). Three rectangular floor slabs, the bottom one supported on four low blocks, are connected by columns in each corner and the center of the long facades, and by a pair of staircases rising along one short end. How the infill was or was not to be detailed was left completely open. No acquaintance, however, with the celebrated architect was necessary for the many builders around the world who employed similar frames to construct structures that owed nothing to his brilliantly experimental spaces, of which the Villa Savoye (1928–1931) is justly the most celebrated (Forty, 2012). Instead the basic system identified, but not invented, by the famous Swiss architect became ubiquitous in the developing world because it was both inexpensive and flexible.

After World War II reinforced concrete took on a new role within an architectural community increasingly committed to abstraction. What had once been avant-garde was now taken for granted, although few attempts were made to repeat the lightweight, stucco-clad boxes that had epitomized the International Style during the 1920s and which had proved difficult to maintain. Instead, the enormity of the task of rebuilding a war-torn cities across Europe as well as East and South-east Asia and of creating the infrastructure of postcolonial South Asia, not to mention accommodating unprecedented urban growth in Latin America, all demanded inexpensive construction. Finish suddenly mattered a great deal less than getting the job done. It was in this context that monolithic concrete, already widely employed in the first quarter of the twentieth century, but not widely popular with the avant-garde of the 1920s, returned to favor.

One of the original advantages of concrete had been that it could be sculpted into a wide array of forms, whose monumentality offered a welcome contrast to the relatively flimsy appearance of ferrous framing. For instance, the Centennial Hall erected in Breslau, Germany (now Wroclaw, Poland), between 1911 and 1913 combined unprecedented clear spans with a much appreciated dignity, arising from the solidity and obvious weight of the material employed (Forty, 2012; Ilkosz, 2006; James-Chakraborty, 2000; Simonnet, 2005) (Figure 3).[2] The collaboration of Max Berg, an architect, and Willi Gehler, a structural engineer, employed by the builders Weyss and Freytag, produced a approach that was not, however, universally welcomed by the next generation.

Writing in 1923, Ludwig Mies van der Rohe explicitly challenged the earlier emphasis on plasticity:

> Reinforced concrete buildings are by nature skeletal buildings. No noodles nor armored turrets. A construction of girders that carry the weight, and walls that carry no weight. That is to say, buildings consisting of skin and bones (Conrads, 1976, p. 75).

Monolithic concrete made a comeback after the war in part because it was inexpensive and in part because of its association with Le Corbusier. The Swiss-born architect'ss *beton brut* for the Unité d'Habitation outside Marseilles (1947–1952), set the tone for set the tone for a new generation of rugged construction Although Le Corbusier and his disciples often made use of concrete's plasticity, they insisted as well on palpable weight married in many cases to aggressively rough finishes (Banham, 1966). Nowhere was this model employed more enthusiastically than in the new capital of the Indian Punjab (Figure 4). Le Corbusier laid out the city and designed its major civic structures. Here, as in Marseilles, the emphasis on sculptural plasticity over a high degree of finish eased the process of coordinating a large and not always highly skilled labor force (Prakash, 2002).

Finally, the technological cutting edge of postwar concrete involved the use of thin shells. Much of the excitement about postwar modern architecture can be credited to elegant lightness achieved by engineers like Pier Luigi Nervi and Felix Candela (Figure 5). Such shell structures arrived relatively early in Dhaka, where they were part of a wave of architectural experimentation that also included buildings by Muzharul Islam, who had trained at Yale and helped secure Kahn the commission for the Second Capital, and the American Stanley Tigerman, who had met Islam when they

[1] Ahmed, A.K., letter to Kahn, L., 12 June 1964, Second Cap Pak/Pak Pu Wk Dept/Correspondence 1964, LIK Box 117, Kahn Collection.

[2] On page 136 Simonnet, however, mistakes the Market Hall for the Centennial Hall.

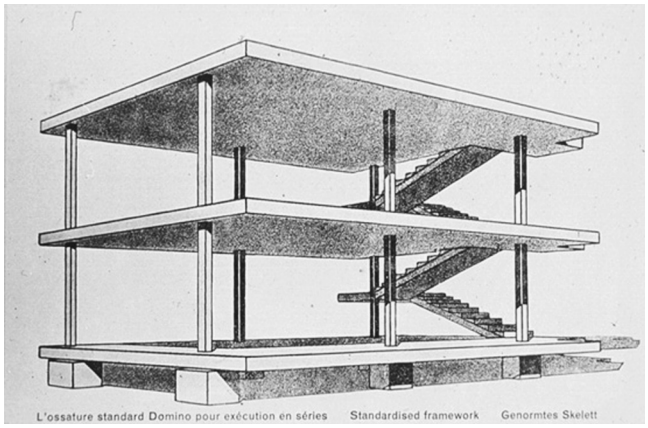

Figure 2 Le Corbusier, Maison Domino, 1914.
Source: Wikimedia Commons.

Figure 3 Centennial Hall, Max Berg, Wroclaw, Poland, 1913.
Source: Digital Library of Wroclaw University.

Figure 4 High Court, Le Corbusier, Chandigarh, India, 1955.
Source: Wikimedia Commons.

studied together at Yale (Powell, 1985). The Kamalapur Railway Station, designed by the American architects Daniel Dunham and Robert Boughey, working for the New Jersey-based engineering firm Berger Consulting, was completed in the 1960s. It features complex, if relatively small shells, which were supposed to echo the form of the lotus flowers common in the region (Islam, 2011) (Figure 6). These lightweight structures form a supple covering at little cost in either footings or materials to a large area with a dramatic decorative flourish of the kind that Kahn assiduously avoided but that also relied on more complex and up to date engineering than he adopted in any of his South Asian commissions. Instead, the tussle in Dhaka would be largely between the first and second of these approaches, although in the end he adopted the third for the National Assembly's parasol-like roof structure.

4. Louis Kahn and concrete up to 1962

For more than a decade before he began work in Dhaka, Kahn had been struggling in his use of concrete to integrate form and structure (Brownlee and De Long, 1991; Goldhagen, 2001; Kreis et al., 2013; McCarter, 2005). The Yale University Art Gallery in New Haven, completed in 1953, the Richards Medical Research Building at the University of Pennsylvania in Philadelphia, dedicated in 1960, and the Salk Institute in La Jolla, finished only in 1965, chart his evolution in the approach to the material from one that combined *béton brut* with structural daring to one that coupled Le Corbusier's emphasis on monumentality and the integrity of the material with a new emphasis on a high degree of finish.

In 1953 Kahn propelled himself into the forefront of American architecture with the completion of the Yale University Gallery (Loud, 1989). The building's most distinctive feature, designed with considerable input from Anne Tyng, was its tetrahedonal ceilings. Although they did not actually support the floor slabs, they did express the loft character of the spaces and expose the mechanical systems. Most of all, their thickness provided the sculptural element that animated the otherwise barnlike galleries, some of which were initially used as architecture studios

Kahn continued to experiment with the integration of form and structure. With the help of structural engineer August Komendant at Richards he employed pre-stressed, pre-cast Vierendeel trusses (Komendant, 1975). This offered a state of the art way to reinvent the daylight factory that had so beguiled Le Corbusier, Mies, and Gropius; brick infill had the additional advantage of enabling Richards to harmonize with its neo-Jacobean neighbors (Figure 7).

The vertical organization of Richards was replaced at Salk by a more flexible, horizontal one, with service areas tucked between the floors of the laboratories. Here Kahn no longer attempted to dazzle with high tech flourishes; the Vierendeel trusses are no longer clearly visible. Instead, in a direct rejection of *béton brut*, he focused on the quality of the concrete, which he left entirely unadorned. Plywood formwork, coated with a plastic resin, enabled him to achieve a nearly velvet finish that echoed the warmth of stone (Concrete Construction Staff 1967; Friedman, 1998). The fortress-like walls that form the little-photographed boundary of the project contrast with more open approach he took in the courtyard. Here he punctured the walls with arcades and filled in the many of the openings at the ends of the second and fourth level blocks with a combination of windows and teak panels (Figure 8). This conversion of a monolithic to a frame construction considerably lightens the composition as well as providing offices with views out over the Pacific.

Figure 5 Cosmic Rays Pavilion, University of Mexico City, Felix Candela, Mexico City, Mexico, 1951.
Source: Wikimedia Commons.

Figure 6 Kamalapur Railway Station, Daniel Dunham and Robert Boughey, Dhaka, 1960s.22.
Source: Shakil Ahmed, Creative Commons.

5. Second capital in Dhaka

Salk provided the point of departure for the approach to concrete Kahn took when he began work on what was originally termed the Second Capital project in Dhaka, the linchpin of which was the National Assembly and is now known as Jatiyo Sangsad Bhaban (Brownlee and De Long, 1991; Kreis et al., 2013; McCarter, 2005; Vale, 1992) (Figure 7). He initially sought to import the same high degree of finish, shorn of the warm wooden infill, into the very different building culture of East Pakistan. Forced to compromise, he developed a system that responded to Pakistani demands that he reference indigenous Islamic architecture as well as to the technical capacities of local construction workers. The result retained his commitment to the integrity of construction. The National Assembly's heft, but not its dignity, was eroded by multi-storey geometrical cutouts on both the exterior facades and those of the major internal circulation space, while the central octagonal volume which serves as the parliamentary chamber, was eventually capped by an parasol-like structure that appears almost to float atop it.

From the beginning the challenges for a relatively small office of building on an entirely new scale in South Asia were daunting (in addition to the Second Capital, Kahn was also at work from 1962 until his death in 1974 on the Indian Institute of Management; a project for Islamabad was terminated by his clients in 1966). He established a small site office, staffed with Americans, but communication between Dhaka and Philadelphia was slow, and architects in both cities had difficulty to adjusting to a workforce that was largely illiterate and thus also incapable of reading plans. A crisis tended to be addressed by a personal visit (he made 18 of them between 1962 and 1970) from Kahn, who would then promise to send drawings that might or might not materialize.[3]

Trust quickly broke down due to the profoundly different motivation of the various parties. The Pakistani government was trying to accommodate East Pakistan's desire to have a say in the running of a country by providing at least a fraction of the new civic infrastructure being created in Islamabad, but the government remained dominated by people from West Pakistan. The Pakistani Department of Public Works presumed that in hiring a famous American, they were availing themselves of that country's prowess in creating state of the art buildings; in fact they were dealing with an one famous for the remove at which he kept an approach to architecture, and more particularly to construction, that he felt lacked integrity (Ford, 1996). Moreover, many members of the Public Works Department were corrupt and looking for kickbacks from contractors.[4] Kahn's loyalty was to his design and not the money he might make from it. Nonetheless, from very early in the process unwillingness of his clients to reimburse him properly undercut his commitment to the project. At the same time he proved unwilling to walk away from an opportunity of this magnitude, even as he slid further and further into debt.

Concrete was key to the sense of the integrity with which Kahn believed he endowed his designs. He came to Dhaka determined to improve a building culture that he deplored not because it was pre-modern, but precisely because of its modernity (he would fare better in India, where at the insistence of his clients he built largely in brick) (Srivastava, 2009). The shift from a relatively low-tech version of concrete framing to an unusually careful one to exposed monolithic construction presented enormous challenges, but he refused to be discouraged. Although he realized from the beginning that "some deviation from construction practice in Dhaka" would be required "to achieve a high quality of workmanship", he hoped to lead by example.[5]

[3]Kahn, L, letter to Secretary, Minister of Health, Nepal, 19 August 1970, Nepal A.I.D. Correspondence, Box LIK 115, Louis I. Kahn Collection, University of Pennsylvania and Pennsylvania Historical and Museum Commission, Philadelphia (hereafter cited as Kahn Collection).

[4]Buell, D., Memo, 14 November 1963, Second Capital Dacca Xtras of Excerpts memos. D. Buell (as well as Masters), Box LIK 19 A, Kahn Collection.

[5]Second Capital Pakistan/Specifications (2 April 1964), LIK Box 19 A, Kahn Collection.

Figure 7 Richards Medical Research Laboratories, University of Pennsylvania, Kahn, Philadelphia, 1960.
Source: Wikimedia Commons.

He wrote in 1965, "All buildings within the reservation of the Second Capital [should] be considered semi-experimental for the sake of inducing better efforts on the part of architects and builders of Dacca."[6]

A memo dating to 1964 set out his specifications:

> Concrete walls, piers, columns, beams, slab soffits will be exposed in the final building, therefore the utmost skill in science, technology and workmanship will be required. Surfaces of exposed concrete are not to be patched, rubbed, or otherwise "finished" in any way after removal of form.[7]

In the same year, he developed the idea of marking the end of each day's pour with marble inserts, which were alternatively flat and projecting. Although their structural role was very different, these played much the same role esthetically, in the way in which they relieved the possibly oppressive quality of the concrete, as the much larger teak panels inserted into the office blocks of the Salk. More importantly for his clients, they echoed the constructional polychromy of Mughal architecture. He had, however, eventually to abandon the vertical grooving, exposing the pattern of the formwork, he employed on the lower levels (Goldhagen, 2001).

Nonetheless it was not always possible for Kahn to reconcile his theoretical stance with what was happening on the ground half way around the world. A 1967 report back to the Philadelphia office, written at a time when the external walls had already risen to the height of several stories, elucidated the continuing conviction by many involved in the project that Kahn would eventually adhere to local practice:

> Basically the problem with the National Assembly concreting is that there are two contractors (they refuse to take tea together) one is a hustler the other a reformed engineer. The first has developed the plaster shot covered from panels with satisfactory results and the latter realizes that his work is not acceptable, acknowledges the results his colleague is obtaining, but refuses to strive for better concreting. He is completely convinced that plastering of concrete shall be the finish. Now, there is the feeling that he is losing his share and before long will disappear from the project.[8]

Nor was that the only problem. Local contractors preferred steel formwork, which would be reused, to the plastic coated wood Kahn demanded.[9] In 1968 Kahn's field representative wrote home asking if construction should be temporarily halted because it would take six to eight months to obtain the synthetic resins required for the manufacture of the polyurethane used to coat the formwork.[10]

Kahn's monolithic approach to concrete represented not modern technology but modernist esthetics. Although more difficult to build properly, it did not encompass an engineering advance on the way in which concrete had already been used in Dhaka for several decades. Instead its palpable sense of heft represented the postwar revision within the modern movement away from an emphasis on lightness towards an engagement with monumentality and permanence. Kahn's distinctive contribution to this development, his insistence on a particular finish, would become the basis of a great deal of what came to be called critical regionalism (Frampton, 1983), especially as employed in Japan by Tadeo Ando.

This was not, however, the only approach to concrete Kahn took in the design of the National Assembly. Encouraged to begin work on the foundations before the design of the entire structure was complete, he eventually had to turn his attention to the tricky matter of how to roof the central assembly chamber in a way that would not compromise the relatively slight walls on which it would sit.[11] As late as 1971, he had still not settled on all the details of the appearance of this important feature; the final structure, designed with the assistance of structural engineer Harry

[6]Kahn, L., letter to Vollmer, R., 25 August 1965, PAC Pending, LIK Box 120, Kahn Collection.

[7]Second Capital Pakistan/Specifications (2 April 1964).

[8]Wilcots, R., letter to Wisdom, D., 8 June 1967, PAC – Correspondence – To/From Gus/June 1967 through December 1967, LIK Box 117, Kahn Collection.

[9]Buell, D., letter to Kahn, L., 9 November 1963, Second Capital Pakistan, LIK Box 19 A, Kahn Collection.

[10]Langford, G., letter to Wilcots, R., 8 January 1968, PAC Correspondence To/Fr Gus/January 68 through December 31, 1968, LIK Box 117, Kahn Collection.

[11]Kahn, L., letter to Khurshid, M., 13 November 1965, Financial Correspondence/Dacca Office, LIK Box 118, Kahn Collection.

Figure 8 Salk Institute, Kahn, La Jolla California, 1965. *Source*: Wikipedia Commons.

Palmbaum, was completed only after his death (Brownlee and De Long, 1991; Wurman and Wilcots 1975).

In other commissions, most notably the Yale University Art Gallery and the Library at the Phillips Exeter Academy, Kahn had appeared to suspend forms of considerable weight atop in the first case a cylindrical volume containing a stair and the second a courtyard (Figure 9). At Yale he inscribed a concrete triangle within the cylinder; at Exeter it was a deep X-brace. The effect in both cases is a sublime sense of menace, redeemed by the way that light floods in from the side. In Dhaka, on the other hand, Kahn and the engineers with whom he worked were forced to adopt a much lighter structure. A parasol constructed of eight parabolic arches set into an octagon, it, too, allowed light to filter in from each side (Figure 10).

In 1965 Kahn wrote of an earlier design that proved untenable:

> The construction of the Assembly ceiling which has been greatly improved after consultation with an acoustical engineer… resulting in a logical straight-forward structure more beautiful than anything else I have made and true to all requirements of structure and acoustics.[12]

The final form, however, bears little relation to the use he made of concrete in any other context in the last two decades of his career, which suggests that it was in part a pragmatic solution to a problem that could not be addressed from within his usual approach to the material. One detail, in particular, hints at this. Radiating out from the center of the figure are marble stripes, set at a much greater density than those embedded into the surfaces of the supporting walls. There they were intended to mark the end of a day's pour and to mask the resultant disruption to what, in the upper stories at least, was a smooth surface, and in the lower ones vertical rather than horizontal striations. This further lightens the appearance of this thin shell structure, which is, however, invisible from the exterior of the building, as it is encased within high exterior walls.

[12]Kahn, L., presentation in Dacca, Pakistan Correspondence – Misc., LIK Box 120, Kahn Collection.

Figure 9 Library, Phillips Exeter Academy, Kahn, Exeter, New Hampshire, 1972.

However, it is unlikely that in the roof the marble insets retained their original function of marking the end of a pour, as the bands are now much closer together. This is as close as Kahn's office ever got to obviously ornamental detailing.

6. Conclusion

Rather than an example of state of the art technology, Kahn's monolithic approach to concrete was an esthetic decision. Its

Figure 10 Parliament Chamber, National Assembly, Dhaka. *Source*: Wikipedia Commons.

palpable sense of heft represented one position within a modern movement divided throughout the 20th-century between an engagement with monumentality and permanence and an emphasis on lightness. Kahn himself was forced to adopt for the roof structure of the National Assembly. New materials and the structural possibilities they provided prompted new forms as well as spaces, but there was never universal agreement about how they should be employed.

Acknowledgements

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